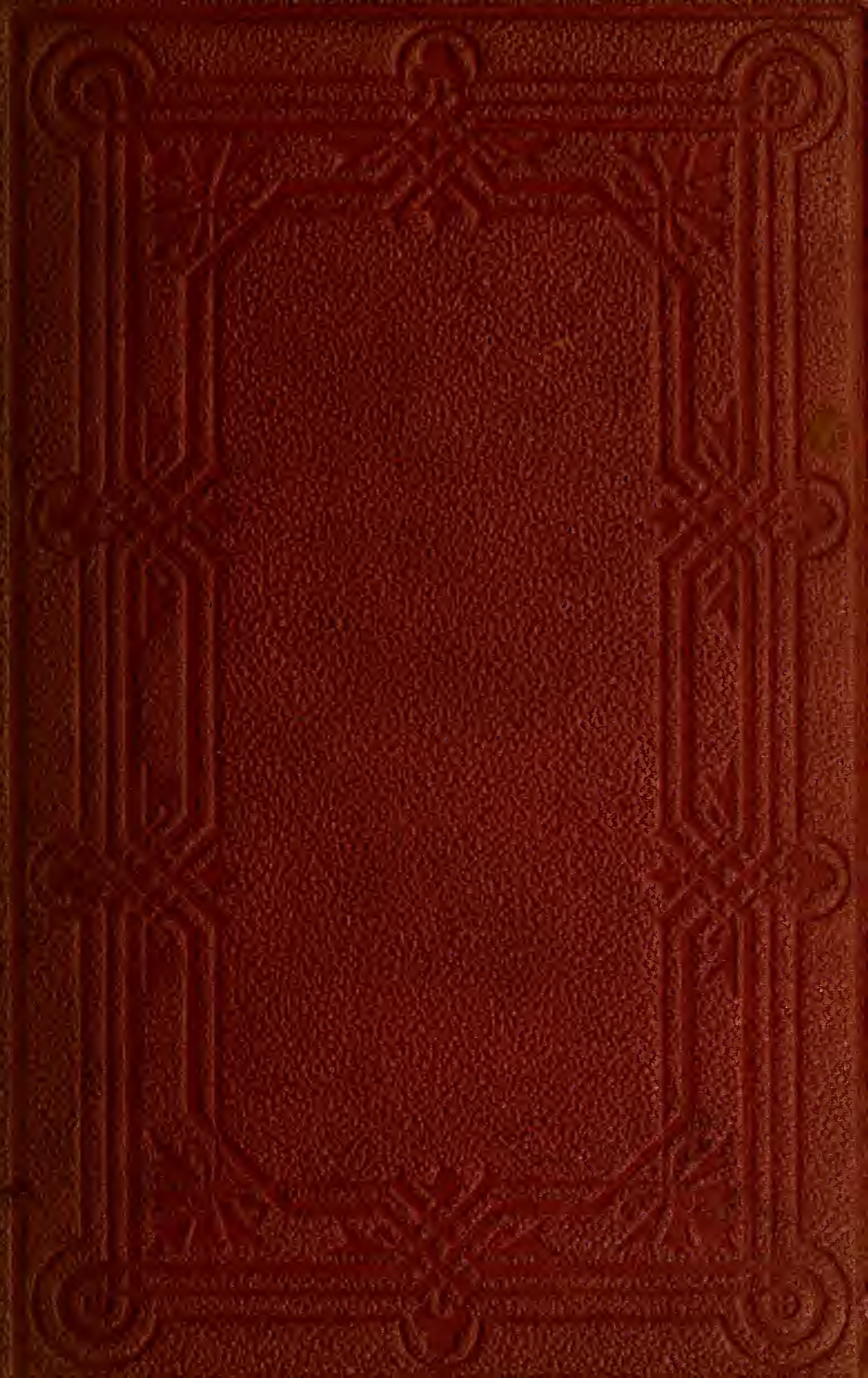

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GERMINAL MATTER

AND THE

CONTACT THEORY.

“There are fundamental truths that lie at the bottom, the basis upon which a great many others rest, and in which they have their consistency. These are teeming truths, rich in store with which they furnish the mind, and, like the lights of heaven, are not only beautiful and entertaining in themselves, but give light and evidence to other things that without them could not be seen or known. These and such as these are the truths we should endeavour to find out.” – LOCKE.

GERMINAL MATTER

AND THE

CONTACT THEORY:

AN ESSAY ON THE MORBID POISONS,

THEIR NATURE, SOURCES, EFFECTS,
MIGRATIONS, AND THE MEANS OF LIMITING THEIR
NOXIOUS AGENCY.

BY

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FELLOW OF THE ROYAL COLLEGE OF SURGEONS, FELLOW OF UNIVERSITY
COLLEGE, ETC. ETC.

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PREFACE

TO THE

SECOND EDITION.

THE first edition of this little work elicited so many favorable opinions from those whose judgment the author prefers to his own, that he now issues a second. He has added much new matter, condensing it as far as possible.

OCTOBER, 1867.

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GERMINAL MATTER.

CHAPTER I.

INTRODUCTORY.

"Vere scire est per causas scire."

We sometimes read of heaps of corn, in fertile and little accessible lands, rotting below while additions are being continually made above; medical literature bears too much resemblance to these accumulations. Facts and observations of the utmost value have been stored up in the archives of medicine in the past, and such are being added still; but matters of the utmost importance, after being insisted on for awhile, are lost sight of for long periods, and facts of equal importance are scarcely ever in equal prominence. The reason is that our facts are in great part isolated, and in numbers so vast that no human mind can firmly grasp them all. The evil is already great in many departments of medicine, in none more so than in that here treated of, and it will assuredly increase unless the relation of the facts one to another can be detected, unless steps are made towards the discovery of the laws which bind the seemingly chaotic mass into the great plan of organic life, of which disease is part. Depreciation due only to baseless theories is too often extended to theory in general; but even a theory which does no more than harmonise a large number of facts is a useful aid to further progress, and is often the means by which we arrive at a law.

Some suppose that we should dispense with theory altogether, and go on collecting facts, leaving it to the future to determine their bearing; when this is attempted observation itself flags, and facts are lost. The best inspirations of a high class of self-styled practical men are often due to a glimmering perception of some doctrine which they have not the leisure to substantiate, and the result is, that the good rules of art which they lay down are soon forgotten, the reasons for them being wanting. Granted for a moment that it were desirable to be rid of all doctrine, it is impossible; the human mind, in the face of a multitude of facts, will form for itself, even if only for artificial memory, some sort of theory, and if pains be not taken to make it broad and enlightened it will be narrow and petty. No other science has ever attained an advanced state without comparison of all its facts, nor will medicine.

The history of medicine abounds with proofs of the influence of doctrine on practice; everywhere we see that correct theory leads to correct practice, uncertain theory to uncertain practice, and wrong theory to wrong practice. The doctrines of Broussais, for instance, produced an immense trade in leeches, lancets, cupping instruments, and bleeding basins. Doctrine is powerful for evil and for good. Under this conviction the author published the first edition of this work. No diligent observer of medicine can have failed to notice that when epidemic disease a little out of the routine of daily practice appears, and this is no uncommon circumstance, methods of treatment are adopted which can scarcely be viewed without concern; at times they have been the objects of censure, more or less public. Censure annoys often without amending, the diffusion of a sounder theory may amend without annoying. The author has stated his conviction that the publication of Dr. Lionel Beale's doctrines would form a landmark in the history of our science; he is since confirmed in that opinion. With less of hypothesis than any other, they harmonise a larger number of facts, they are calculated to effect practical good, they throw light incidentally on many points of detail; we generally find error barren, and truth fertile.

Medicine offers to her votaries many subjects of great and varied interest; among them all the cause of the epidemic and contagious diseases is one of the most attractive as well as of the most important. The influence of that class of diseases on the vigour, the increase, and the decline of races, is so great as probably far to exceed in importance that of armour, offensive or defensive, and military courage and skill. Their subtle causes go far to determine the allotment of the surface of our planet; the reader of history knows that whole races, well-fed and living in much physical comfort, have fallen before them.

The advent of pestilence is a strange and searching test of men and nations—here the meanest, there the noblest, qualities are unexpectedly revealed to view. In one community the social tie is broken, society is utterly disorganised; in another the greatest of Christian virtues are displayed, the bonds of society are drawn closer by the common danger, and the rich, the powerful, the healthy, and the respectable, more fully learn how many interests they have in common with the poor, the weak, the sickly, yes! and even with the vicious, for the destructive mote which strikes down the homeless and friendless vagrant may equally carry anguish to royal towers and fill the land with mourning.

Sydenham did not believe smallpox to be contagious; it is just two centuries since he was attributing that disease to an "occulta crasis" of the air, a "constitutio epidemica." This favorite idol has been brought out and rejuvenated in the year 1867. Since the discovery of the active particles of germinal matter in vaccine by Dr. Lionel Beale, the expression is as much out of date as "phlogiston." When Boerhaave succeeded in obtaining a general recognition of the contagious nature of smallpox, he removed a great obstacle to the discovery of inoculation and vaccination. He himself suggested the possibility of an antidote, though he expected to find it among drugs. Sydenham, as a physician, was *nulli secundus*. How is it possible that so acute an observer could have overlooked the contagion of smallpox? The question is fraught with lessons to ourselves. In the London of his day the poison was in the air—it was everywhere. Few escaped the disease, and these owed their immunity to the absence of predisposition, not to the absence of the virus. Amidst the abundant cholera-poison of Calcutta they do not believe in contagion; yet to live through the frequent epidemics there is a tolerable proof of the absence of any very high degree of predisposition; the wearied attendants, they tell us, have thrown themselves, to snatch a little rest, on the beds of the dead and have not taken the disease. This is the kind of evidence which caused Sydenham to disbelieve in the contagion of smallpox. The newly arrived very frequently suffer, they admit; but to keep off reflection, and cover our ignorance, acclimatisation—a long word, utterly unexplained—forms

> "A right good shield of hides untanned."

We hope further on to obtain a glimpse of its meaning.

On the other hand, in distant islands, nobody doubts the contagious quality of cholera. There they know what man, or at least what ship, brings every epidemic, and from what port. To reconcile these discrepancies we find it said that it is sometimes contagious and sometimes not, which, in the case of so highly specific a malady, is very much like saying that groundsel comes up in your garden, sometimes from seed and sometimes not, according to the accident of your knowing how the seed came there or not. Contagion becomes conspicuous when almost absent—a curious instance of the truth of Aristotle's maxim, "that the nature of everything is best seen in its smallest portions." And here we may appropriately advert to the fact that the discovery of vaccination was not made in a great town, where all the appliances of science abounded, but in the secluded vale of Berkeley, where the facts of contagion were so much more patent. To have insisted on the exclusively contagious origin of smallpox in Sydenham's reign would probably have placed the advocate of contact—

"Like feather bed
'Twixt leaguer'd wall
And heavy brunt
Of cannon ball,"

a position of which the distinguished men who early insisted on the origin of cattle-plague by contact have some experience. It required the hardest logic of facts to bring the nation to their mind.

Half understood contagion is an inconvenient doctrine; it gives trouble, it alarms, it hampers friendly intercourse, and shackles trade; thoroughly understood, it gives very little encouragement to quarantine, especially when not aided by the sea; and in that case the cleanliness of the ship takes the important position which the cleanliness of the house occupies on the land, and it requires at least as much attention as the passengers. On land a floating particle may in a thousand ways elude the strictest cordon. Quarantine nearly always delays the spread of disease, unless of the more diffusible kind, such as influenza; but it must be expected frequently to fail, and free transit is as important as free trade to the commerce and to the brotherhood of nations. Besides, there is reason to believe that when an epidemic is kept off for a long time by insular position, which is a natural quarantine, it is more fatal when it arrives. But the doctrine of contact does encourage the utmost disinfection and cleanliness about the sick, free ventilation, and the removal of absorbent materials; you best intercept the thistledown at the thistles. It enforces also the most careful disposal of all excreta, and especially the cleansing of those habitations which are the favorite haunts of epidemics; and this, if conducted with kindly sympathy, will leave a moral as well as a physical benefit behind.

To maintain, as is often done, in effect, if not in words, that it is necessary, here in England, to warp the facts of medical science in order to prevent Englishmen from neglecting the sick, is to mistake the national character, and to overlook its resolute sense of duty. I do not think that the effective study of epidemics can be fairly said to have begun till their general origin by contact is admitted; the evidence is of the same kind as it used to be in smallpox, exposed to no greater degree of doubt than is fully explained by the ease with which slight cases, which are so important in tracing infection, are recognised in the case of smallpox as compared with the difficulty in other cases. I make no distinction between contagion and infection; they are so hopelessly confused in the common use of the words, besides being in essence the same; both are included in the "Contact of Germinal Matter."

A great, and to some extent needless, difficulty is created by the separation of severe cases from slighter ones, due to the same poison, as of cholera from rice-water purging; the links of contagious succession are thus broken. It must be admitted that there may be great practical difficulty in registering them together; but no inquiry into the question of contagion is worthy of the name in which these slight cases are not looked for with far more care that the severer ones, on account of the far greater probability that they will be overlooked.

The success of the method of checking cholera among marching troops, by breaking them up into detachments, depends on its spread by contagion. The Rev. Professor Haughton has shown that, on very simple mathematical principles, the density of a population would be a factor determining the ascent of the curve of increase of an epidemic; this would be in the case of no very exceptional distribution of the poison being made, as, for example, by a water company. I believe that bad sanitary state of any kind would be equivalent to greater proximity.

In some diseases, typhoid fever for instance, the symptoms in the early stage are not always severe, and the patient may even go about at this time; where this is the case, it gives an alarming character of suddenness to the deaths. In plague this was specially so; the plague spot, vibex, carbuncle, or bubo, was the beginning of the end, though occasionally it seems to have been the first thing to attract attention. The slighter cases are apt to be separated from an epidemic and called by another name, to the confusion of our ideas, and so are the severer ones; thus, cholera, when rapidly fatal, with scarcely any purging, in Rome or Jersey, or elsewhere, becomes a "morbo occulto." The recent purpuric epidemic has been divided into three; it seems strongly allied to scarlatina, though with specific differences. First, the severest cases, rapidly fatal; malignant purpuric fever. Next in order, the cases called cerebro-spinal meningitis. The slighter cases, far the most numerous, are chiefly described as rubeola maligna, but there is in them a tendency to throat affection, the skin peels as after scarlatina, the eruption is purplish, with a tendency even to vibex, and neither measles nor scarlatina protects against it. Dr. Stokes, I believe, first indicated the relation of these latter cases to the others. If we include the occurrence of purpuric spots in other diseases, we find the effects of one cause classed under at least four separate heads.

In concluding this introductory chapter, I will just notice an objection which has been made, that the popularisation of doctrines which assign a natural history to disease would leave no room for treatment. I would ask those medical gentlemen who feel a difficulty of this kind, to compare our position with the public in reference to smallpox with our position in reference to cholera. Passing over the prophylaxis of both, we do not find that, because we at once acknowledge, and the public know, that smallpox has a natural history, independent of treatment—that it runs a certain course—we do not therefore find that they attempt to dispense with our services; they know, and we know, that we can often, in a hundred ways, influence the progress of the case, make the difference of much or little disfigurement, of complications or no complications, even of life or death; and, besides, that we can guide them in measures to prevent the spread of the disease. But in cholera ———————— it is better only to suggest the contrast to the medical reader rather than to complete it.

CHAPTER II.

A MEDICAL THEOREM.

> "Admiranda tibi levium spectacula rerum
> ——— dicam."

In order to remove some obstacles out of our path, I must prove a medical theorem. We shall arrive at it by three easy steps. The first step is this:

I. Air floats with ease and for a considerable time and distance light and small masses of matter.

It can carry large and heavy ones.

Standing on the extreme edge of a river, a strong gale blowing over three hundred yards of water and wet mud, I have collected particles of quartz of considerable size which had struck me with stinging force on the face.

Volcanic dust and the sand of the African desert have fallen on ships far out of sight of land.

Place on a table in an ordinary apartment a broad sheet of blue litmus paper, and in the centre a tall open vessel of very weak sulphuric acid containing a clipping of zinc. Minute but visible globules of the acid fluid rise in the air; when the quiet effervescence has gone on for some time, the reddened paper will show that these have floated to some distance.

On a calm day, looking from a height at a dusty road crowded with foot passengers, you will see a cloud of fine dust, heavy particles, mostly silica, hanging over its whole course, and still more so if there are horses and wheels. The dust on the grass and hedges near roads and footpaths tells the same tale.

From a hill-top, when there is a gentle breeze and the air is clear, observe the smoke of a village trailing miles away; it will not be doubted that the smoke consists of solid particles.

On a still, hot summer afternoon it is a pleasure to watch the gossamer spider carried aloft on the fibres he has spun by the action of a current of air not strong enough to be perceptible to the hand.

The seeds of the thistle and taraxacum, by the help of their parachutes of bristles, sail high in the air; I have noticed them float past me on church towers at the height of 200 feet. The spores of many fungi and the pollen of plants pass freely through the air, and can be collected on a glass wet with glycerine.

Odoriferous particles, tiny globules of essential oils, are borne immense distances. This is well and long known—

> "As when to them who sail
> Beyond the Cape of Hope, and now are past
> Mozambic, off at sea north-east winds blow
> Sabæan odours from the spicy shore
> Of Araby the blest; with such delay
> Well pleased they slack their course, and many a league
> Cheered with the grateful smell old Ocean smiles."

Of all winds, the dry, persistent north-east, the polar current, carries with it most fine solid matter; it is colder, and, being therefore more dense, has greater floating power; it scarcely ever looks clear in town or country.

The dryness of this wind causes water to evaporate with rapidity; now, if it be desired to raise into the air the finest particles of a solid substance, there is no more effectual method than to mix them with a volatile fluid capable of thoroughly wetting them, and to evaporate briskly. In hot weather the rapid evaporation of spirit of turpentine carries the heavy but fine particles of carbonate of lead into the air of a newly painted house, so as to render it extremely deleterious. The so-called effluvia are merely particles of the solid carbonate suspended in the air. The rapid evaporation of water from soil at a certain stage of dryness carries up all particles which are sufficiently small and light, whether mineral or organic, vegetable or animal, dead or living. Rain brings down these particles, and even moisture not in excess aggregates and precipitates them, and renders the air transparent.

II. Minute portions of organic matter are constantly thrown off by animals and men. This is our second step.

Unless it be from the teeth or nails, there would be difficulty in naming any surface of the body, internal or external, from which they are not, and this occurs especially in deviations from health, even though but slight. From the epidermis in its perfect condition there come only its dead scales, its sweat and sebum. But it is rarely in this condition over the whole body; a pimple broken sets free the pus-cell; small spots of skin disease throw off the epithelium-cells prematurely, or discharge an ichor, which dries into the thinnest scales.

The mucous membrane in perfect health is said to form a hyaline mucus without even the mucus-corpuscle. This is almost an ideal state.

Very large surfaces may throw off their epithelium, as of the small intestine in cholera. Some say this is after death, and it may be after systemic death, but unless produced by putrefactive change like the peeling of the cuticle from a corpse, in which case it is of no importance, the tissues are not locally dead, or else it would not occur—a consideration unaccountably overlooked. In scarlatina, the kidney often desquamates as well as the skin. The conjunctiva in ophthalmia, the airways in coryza and bronchitis, the alimentary tract in diarrhœa, dysentery, &c.; the genito-urinary surfaces in cystitis, gonorrhœa, and syphilis; in fact, the whole inner skin throws off, according to the nature of the irritation to which it is exposed, its epithelium, the mucus-corpuscle and all its modifications, the pus-corpuscle, the compound granular corpuscle, nuclear or molecular matter, blood, and even small shreds of its own substance. The matters we have spoken of in little pellets of mucus fall in the dust, dry exteriorly, and remain moist within, and with adherent fibres the *débris* of clothing, &c., must often bear no inconsiderable likeness to seeds or spores with the fibres attached, by which they are borne on the wind. Something similar will take place when dried on woven fabrics and broken off; or they may be thrown into the air in so minute a state of division as never to touch the ground till they reach their destination. Sneeze into a sunbeam penetrating a dark room, and you will see myriads of such particles, all containing organic matter, as small as the globules of mist or cloud. The rapid evaporation of water from these, or from drying excreta, or from the lungs is, as we have seen, the very condition required to load the air with the finest organic particles. In the rooms of the sick, in forecastles of ships, in overcrowded houses, in the air surrounding thick habitations of men—especially where, as is far too often the case, urine and fæces are allowed to dry and rise in dust—particles of such organic matter are suspended in the air; they form part of it. It is the sensible absence of such particles which makes us breathe with so much zest, the air of the mountain, or the sea.

The third step is—

III. These particles are received into the body, and some pass into the lungs, so as to reach the blood.

They enter the eye, the mouth, the throat, the alimentary canal, and especially the airways, and to these I wish to direct particular attention. At this point I will crave my readers' pardon for asking them to call to mind the last London fog—how impossible it was to keep it out of their houses, how it made their eyes smart, was smelt in the nose, tasted in the mouth and throat, and felt far down into the lungs, and seen hours after in the expectoration—their doing so will lend force to my argument. We will follow the air as it approaches the nostrils, carrying with it all that it holds in suspension, which, as we have seen, may not be little; it proceeds with increasing velocity as water to a sluice; and let me not be supposed to undervalue nature's means for preventing the entrance of impurities. The air, first strained through the hairs which protect the nostril without and within, next passes in a thin layer between moist surfaces, sensitive both with olfactory and ordinary sense, then impinges on the back of the pharynx, and here the heavier particles, if not stopped before, are likely to be retained, to be eventually swallowed. Afterwards, it has to pass a portal guarded by the most acute sensation, the slightest irritation of which is sufficient to reverse the air current. Once past the glottis, there are long tubes diminishing in calibre, their surfaces moist, and if even here, in the slackening stream, the particles touch and adhere, there are ciliæ ready to bring them in mucus to the glottis, to be expectorated or swallowed. Can anything escape so elaborate a respirator? The lungs of dry grinders and masons tell us too plainly that even particles of steel and silica large enough to feel gritty in the tissue of the lung, and to be easily found when that has been by heat or chemistry destroyed, may do so; and yet such particles are almost pebbles for weight and size compared to the little masses of surface-dry organic matter to which we have directed attention. These are in specific gravity so much lighter, and, while originally they may be of excessive minuteness, are further diminished by partial drying. In the act of inhalation we draw them far into the lungs to surfaces wet with liquor sanguinis, to the very air-cells, that is, to the blood,

Sacratâ sistimus arce.

Three steps of proof lead to my theorem. They are—

1st. Air floats light little masses long and far.

2nd. We are always throwing off light little masses of matter.

3rd. These enter the body by different channels, especially by the airways, whose natural defences are insufficient to prevent them from going to the air-cells—to the blood.

My theorem, which follows as the inevitable conclusion, is,

That light little masses from the body of one individual are constantly received by other individuals so as to reach their blood.

This would be merely a disagreeable conclusion but of little moment, were it not that some of these matters are either living or contain living matter; and living matter, as we know—matter in a state of active growth—has the power of exciting living action similar to its own in suitable material.

For the sake of those who are not familiar with the views of Dr. Lionel Beale on the function of germinal matter in growth, nutrition, and inflammation—a deficiency which I would counsel them at once to remedy by careful study of what he has written on those subjects—some explanations are necessary which will occupy the next chapter.

CHAPTER III.

GERMINAL MATTER.

> "Things that are seen are not made of things that do appear."

This is certainly true of all organic nature; huge trees producing the hardest timber, the bulkiest and strongest animals, in fact all organic beings, including ourselves, at a sufficiently early period in the spore, the ovule, or the ovum, were once in a soft embryonic condition, semi-fluid, translucent. As with the whole so with its parts; every portion of our bodies, every cell, was once this soft translucent material, "germinal matter." This is the primordial condition of all our textures, from the hard enamel of the tooth down to diffluent mucus. We must carefully distinguish this, the germinal matter, from the formed material, tissue which has completed its growth, such as cell wall, or different kinds of fibre; to these Dr. Beale allows no vitality, thinking that their properties may be explained by physical laws. There are many who feel difficulty in admitting the formed material to be entirely dead, but it cannot be controverted, and is sufficient for our present purpose, that life, growth, and multiplication are the especial characteristics of the germinal matter. Present this clear, living, glassy substance, quite isolated from formed material, to the expertest microscopist, and he cannot tell you from what texture, from what species, from what class or kingdom of nature it was taken. Germinal matter is alike throughout creation. Whether it have structure though invisible, or whether, as Dr. Beale believes, its ultimate chemical atoms are unattached till called to obey vital, that is, unknown, forces; just as particles of steel lie loose till the magnet approaches, we do not know, but it certainly has no visible structure. No magnifying power, no modification of light reveals any, yet life and all that the word implies of terrible or beautiful, is concealed in it; the crassest ignorance, the highest science, are on a level in its comprehension. Many vegetable products and some animal have been built up, step by step, in the laboratory of the chemist, but he can no more create from inorganic matters a particle of germinal matter than he can create a man. Casting aside all unpractical speculation as to its first origin as useless or mischievous, we need not hesitate to adopt Dr. Beale's modification of Harvey's maxim—

"Omne vivum e vivo."

When brought into contact with suitable liquid material, germinal matter absorbs it; on this property, I think, depends Dr. Beale's test for it. His ammonia-solution of carmine much more readily stains the germinal matter than the formed material. The old and valuable series of experiments by which the mode of growth of bones was determined in madder-fed pigs shows that colouring matter, quite adventitious, is absorbed by germinal matter in the body during life, and may remain long after colouring that part of the bone, and that only, which grew while it was circulating in the blood. Other instances of colouring by food, of shells for example, occur lower down in the animal kingdom.

Germinal or nuclear matter has a rather high refractive index, which occasionally causes a little difficulty in distinguishing it from the fat globule.

Germinal matter, in certain forms, has the power of dissolving formed material; thus in diseases of the joints, fringes of vessels covered with germinal matter readily dissolve the solid cartilage; accepting the fact, we have the key to absorption as well as ulceration. Interstitial absorption presupposes interstitial ulceration; for without the breaking down of the interior of a solid mass into a condition of very minute division or a fluid, absorption would be impossible.

The health of a patient largely influences the development of germinal matter as seen on a sore, and it may do this, as we shall see further on, in two ways, either through excretory matters of a chemical nature retained in the blood, or through the germinal matter of the thoracic duct and blood-vessels, chyle cells and white blood cells; these must vary with the absorption of every day's food.

Masses of germinal matter move, divide, and subdivide, as may be seen with proper care, skill, and patience, in the case of the white blood cell, the mucus and pus corpuscle, the amœba, or the cell of common mildew; and this latter gives an excellent example of the property of the lower forms of germinal matter long to retain life within, however dry and dead they may be without. This power is of great importance when viewed in conjunction with the facts brought forward in Chap. II.

Dr. Beale advocates the principle that the less germinal matter is organised, the more it is prolific, and the more tenacious of life, and he applies it to the following series: healthy lymph, inflammatory exudation, pus, and the germinal virus of the contagious diseases. For details I must again refer the reader to his different works and papers. The pus cell, for instance, Dr. Beale has seen throwing out protrusions and detaching new corpuscles after being kept forty-eight hours in weak warm urine. Germinal matter can also retain its life in the midst of dry, dead, formed material, as within the epithelium cell or the pus globule, probably for a much longer time.

This occasional dormancy of life is no exception in nature, besides eggs and seeds, which are prepared for such a condition, other instances abound. Many low forms of vegetation, such as the common *Protococcus viridis*, grow only when the air is moist, and when it is dry are dormant; infusoria, some of which resemble lumps of germinal matter, do so. The vibrio of wheat is a remarkable instance.

Some insects, either in the grub, the chrysalis, or the perfect state, remain in a state of suspended vitality for long periods; but it will be said this is merely hybernation, it is due to the absence of caloric. No! for a vertebrate animal the mud-fish of the African rivers passes the dry hot season moist in the midst of a cake of baked mud, so that a low temperature is no essential condition for this suspension of life.

On the other hand, larvæ, pupæ, and eggs of insects, have been long ago exposed to temperatures below zero, Fahr., afterwards reviving and continuing their usual development. And recently Dr. B. W. Richardson has shown that the cerebrum of birds and mammalia may be frozen, and yet that the ganglionic cells and delicate germinal matter may resume their usual functions.

If, then, these higher forms of life can be thus suspended with impunity, it is little to ask of the reader to believe that a mass of germinal matter, inferior in the scale of development to the pus cell, may also sometimes exhibit considerable tenacity of life.

In the previous edition of this work I referred to the snake poisons as of extraordinary permanence, Dr. Christison having found that of the cobra, when dried into a mass like gum arabic, active after fifteen years; but I expressed a doubt whether they might not be more allied to the cantharidine and formic acid of the Spanish-fly and the ant. Professor Halford has since stated that they are of the nature of germinal matter, and that they give rise to a rapid development of peculiar cells in the blood of the victim. A vitality so prolonged is far beyond anything required to explain the ordinary facts of epidemics. The durability of the specific poison of smallpox and vaccinia, as seen in the dried scab, or on points, or remaining active in glycerine for more than a year (Müller), is probably sufficient.

The development of germinal matter appears to me to be mainly influenced by three classes of circumstances, which have a common element.

1. By contact with formed material.
2. ,, ,, chemical substances.
3. ,, ,, other germinal matter.

I. The development of germinal matter is influenced by the nature of the formed material with which it may happen to be in contact.

Throughout the body the blood is the same; its clear nutrient part, the liquor sanguinis, is the same; the free germinal matter, whether the white blood cell or in smaller particles, is the same for all textures, yet in each case the new tissue formed is that with which the germinal matter is brought into contact.

When a cut heals, capillary is joined to capillary, nerve to nerve, and skin to skin; when a large nerve or tendon is cut, or a bone is broken, nerve, tendon, or bone is formed between the ends; when a large ulcer heals, if the whole depth of the skin have been entirely destroyed, cuticle is only formed at the edges in contact with cuticle. An entire bone may be regenerated if the periosteum, never free from bony particles, remain.

A vascular part of the body cut off and quickly replaced may adhere and grow as before. Plastic surgery frequently transplants skin to neighbouring parts. Taliacotius made the skin of the upper arm adhere to the face. The transplantation of teeth and various bizarre experiments on animals, show that a portion of one individual may be grafted on to another, even of a species widely different. The foregoing, as well as the phenomena of the formation of monsters by the adhesion of twins *in utero*, are instances of the development of germinal matter, influenced rather by the accident of contact than, so to speak, by the intention of nature,—that is, by any co-ordinative power.

II. Chemical substances influence the development of germinal matter. A few instances must suffice.

To an ulcer covered with pale flabby granulations, apply the common sulphate of zinc lotion, and the opaline coating which hides the florid blood becomes transparent, formed material being reabsorbed.

The clear lymph which coats the steep edge of a phagedænic ulcer, and is dissolving the solid skin with rapidity, will often cease to do so, if brought into contact with a strong solution of opium; given internally, the drug has the same effect.

Arsenic proves its influence on germinal matter in eczema and some other skin diseases. The silver stain of the cutis, consequent on the prolonged administration of nitrate of silver, is situate in the rete mucosum, the layer of that material designed to replace the cuticle.

Quinine and other tonics, besides other modes of action, check the abundant formation of mucus or pus; that is, they restrain the growth of germinal matter, the so-called proliferation of cells. Can this be one use of the quinine-like substance discovered in the blood through its property of fluorescence, by Dr. Bence Jones?

Among dietetic substances, alcohol, the fats, and the vegetable acids, have this effect. Cod-liver oil hinders, it would seem, the proliferation of cells in tubercle, and probably in cancer and other diseases. Alcohol has the same effect very strikingly in the later stages of fevers, and in excessive suppuration.

Ammonia instantly, cantharidine more slowly, causes the germinal matter of the rete mucosum to cease the formation of epithelium. The increased flow of blood cannot explain this, or else blushing or erythema should alter the nutrition of the skin; or if it be objected that a remora of the blood is also necessary, we have that in prolonged congestion, or during the application of Junod's boot or the cupping-glass. The pigment mark, which often remains after a blister, shows that the germinal matter has been altered. Heat also can blister; and we see, from sunburns, freckles, and the brown stain of the legs, from cowering over the fire, that this also alters the germinal matter of the pigment cells.

Looking to the great absorbent power of this substance, and the extent to which its development is controlled by such absorption, the medical sceptic may look to the future of therapeutics more cheerfully than he has done; but the phenomena of slow mineral poisoning show that much caution and watchfulness are needed in our experiments.

III. The development of germinal matter is influenced by the tendencies of other germinal matter, with which it is brought in contact.

It is even possible that the facts under the first head, that of contact with formed material, may be really due to contact with very minute portions of germinal matter contained in it.

But we must deal with this subject in a separate chapter.

CHAPTER IV.

THE CONTACT OF GERMINAL MATTER THEORY.

"Commercia corrumpunt mala."

Contagion is merely an important branch of the subject which we have now to consider; we must fix our attention on something of wider import—on that property by which morbid action, more or less specific, spreads from tissue to tissue by contact, whether direct or indirect.

I. By direct contact with tissue in a state of morbid action. The contact may be either with or without continuity.

1. With continuity of tissue.

When erysipelas travels, say from the ala nasi across the face, with sharply marked edge, mass after mass of the germinal matter, which under ordinary circumstances grows so slowly as merely to supply the waste of the textures of the true skin, producing little formed material but that of high organisation, begins to increase with rapidity, producing much more formed material, but of low organisation. One—would say there is exudation, another—there is proliferation of cells; abundance of corpuscles and granules are found, and it is impossible to deny that the germinal or nuclear matter has been in a most active state. Nothing that we know of the function of either vessels or nerves, warrants us to suppose that they can do more than indirectly influence the result; they owe even their own origin and maintenance to germinal matter, and this inflammation shows no tendency to limit itself to the area of distribution of any vessel or nerve whatever.

In this disease, as in very many others, in boils, carbuncles, and other inflammations of more or less special tendency, we see how much easier it is for morbid action to spread by contact than to establish new centres. Our ordinary medical language recognises this truth; it is one of those analogies of inflammation with fire which conferred the name.

2. Without continuity of tissue.

If inflammation of the lung reach the surface and involve the pulmonary pleura, the costal pleura takes on the same action; there is here no continuity of tissue either of nerves, or of vessels, or of any kind whatever. There is no reason why the opposite surface should suffer, except its contact with the effused lymph, which is full of germinal matter. That there is no irritating quality in the mere lymph apart from its tendency to active growth and increase, we know from the fact that when its active growth ceases, a quart of it may remain for months, causing no irritation, but being slowly absorbed.

In like manner, if inflammation of the intestine, liver, or other abdominal organ reach the peritoneal covering, the opposite surface of the peritoneum inflames also. Peculiar inflammations of the skin, verrucæ, intertrigo, and others, very quickly attack the opposite surface in contact with them. The effect of cleanliness and dusting-powders in eczema and other skin diseases, shows that the discharge of these also helps to spread the disease; it is surely the merest hypothesis to suppose a special something which is being eliminated in all these cases: we know that the lymph is loaded with particles of germinal matter.

It may be replied that in some of these cases there was a predisposition to the specific action; and this is not denied. When analysed I think it amounts to saying that the enemy was within the body as well as without—that some of the specific germinal matter in question was circulating in the blood; and though this would render the patient's body, as a whole, more liable to suffer, it would still leave open the question we have endeavoured to answer—Why one part and not another should be affected.

II. By indirect contact, that is, by the transmission of morbidly active particles,

1. From part to part of the same body.

Dr. Beale has amply proved that the formation of pus is a rapid increase of germinal matter of low organisation. We find that the pus of gonorrhœa will occasionally produce severe ophthalmia.

Mucus, also, is full of living particles; in severe diarrhœa these irritate the skin about the anus; in severe coryza, the upper lip; and this is not a mere general soreness produced by too rapid removal of the moistened cuticle, but is usually punctiform, showing that separate cutaneous glands have been the centres of action.

In bedridden patients the expectoration of phthisis often marks its passage along the back of the windpipe by rows of ulcers, ceasing at the glottis; the same secretion would appear sometimes to cause tubercular ulcers of the intestines; through the œsophagus it passes rapidly, and the epithelium is thick, and the gastric juice in the glands would not readily allow it to act on the stomach; but when that organ is empty, it might readily pass through. I have seen the tops of the rugæ and valvulæ conniventes apparently affected by morbid secretions from different sources passing down the alimentary canal.

An unhealthy wound—any kind of sore—will set up irritation or suppuration through the lymphatic vessels in the glands to which they run—that is, germinal matter from the wound gives rise to the formation of similar germinal matter in the gland, and the lymphatic is not by purpose an excretory system, or it would not discharge into the thoracic duct.

The explanation of the so-called sympathetic bubo of gonorrhœa is similar. In the same manner tubercle or tuberculoid matter may pass from the intestine to the mesenteric, and from the lungs to the bronchial, glands. Cancerous matters also seem to prefer these channels to those of the general circulation, though not to the exclusion of the latter; in both we find germinal matter, and it is, doubtless, in all cases not the formed material, but the germinal matter which is the inoculating substance.

In its later stages cancer certainly diffuses itself through the general circulation; occasionally this is very well seen in melanosis. A closer search will render it almost equally evident in other cancers. Pus passing into the systemic veins gives rise to purulent deposits; and in dysenteric and other intestinal ulcers, through the portal vein, it causes abscess of the liver.

Dr. Beale has shown that while the fluid in which they are contained is in motion, the white blood cell, pus cell, and similar masses of germinal matter, remain of roundish form; when it is at rest they throw out fine processes, which increase their surface, and therefore their rate of nutrition ('Microscope in Medicine,' plates vii., xx., xxviii., xxix., xxxiii.). The pus cell, then, which had been carried, a rounded mass, by the flowing stream of blood, when it arrives in the capillaries where the current is slow, especially if they are dilated, and still more if they are obstructed, throws out its processes and begins to multiply, and thus gives rise to a secondary deposit. There is no doubt that the smaller of such corpuscles, whatever their specific nature, pass freely through the capillary walls; in the germination of cellular plants they pass through the cell wall, and when under the microscope the web of the frog's foot is long irritated, after some time germinal masses are seen outside as well as inside the capillaries.

2. Lastly, by indirect contact germinal matter may pass from one individual to another.

This includes the case of inoculation, together with contagion and infection. The general indiscriminate use of the two latter words renders distinction between them hopeless, and it is not very important, as their essence is the same, though their accidents may differ widely. Some of the cases under this head are far less indirect than many under the previous, as gonorrhœal pus passing between the follicles of the cervix uteri or vagina and those of the urethra; or chancre between genital mucous membrane and skin; or the cases of vaccination, inoculation, and syphilisation. In these latter cases the poison is carried by an intentional bearer. It is frequently conveyed by accidental bearers; such are vehicles, ships, garments, bedding, &c. Next there are fluid bearers, as water for the poisons of cholera, and tropical dysentery, perhaps typhoid fever—in fact it would seem more particularly for those poisons which chiefly affect the alimentary canal; and lastly air: and on this subject I have insisted at length in the second chapter, because it has appeared to me that the difficulty of conceiving the transit through the air has been a stumblingblock to many.

CHAPTER V.

FIRST TRACES OF CONTAGIOUS AND PROTECTIVE INFLUENCE.

"Vires acquirit eundo."

The line of demarcation between healthy and morbid germinal matter, like most other natural divisions, is by no means sharp and decided. One day a patient has a healing wound covered with small, red, healthy, granulations, and cuticle is forming rapidly at the edges in bluish films. Some slight cause, dietetic or other, disturbs him, and before the pulse or epithelium of the tongue gives warning of anything wrong, the germinal matter of the granulations becomes less transparent; it produces more formed material but of lower organization, allows less of the colour of the blood to show through, and new cuticle ceases to be formed. In another patient of different constitution, the granulations will ulcerate, and the ulceration extend to healthy skin. In another there will be a tendency to sloughing. Aggregate a number of these patients, even though they be men selected for their health and strength, pack them too closely, neglect cleanliness, and you have soon an inoculable poison. The aggregation of puerperal patients is even more dangerous. The wounded and the lying-in, besides suffering more than others from ordinary epidemic diseases, suffer also from special varieties of surgical and puerperal disease. As to whether they are inflammations or fevers, logomachists have fought, and logomachists will fight. To those who hold, I quote Dr. Beale's words, "that the changes of the germinal matter of the tissues generally in fevers, precisely resemble those observed locally in inflammations;" there seems little occasion for contention, though certainly many of the cases are on the borderland of these two classes. In all of them germinal matter undergoes enormous and irregular development.

For different reasons, both in the wounded and the puerperal, germinal matter has been more than usually active; in the one to heal the wound, to form lymph or pus, in the other to nourish the child; if the cause of these fevers be germinal matter having some specific tendency, it is easy to see why in the wounded and the puerperal, the latter especially, its effects should be more serious. There are, however, two kinds of surgical and puerperal fevers with which germinal matter has no concern; one produced by absorption of putrescent liquids,—this is very quickly remedied by measures which cleanse the absorbing surface, such as removing sloughs, fragments of placenta, and so forth; the other caused by emboli of dead or formed material, shreds of tissue, or masses of fibrine, in which there is much less scope for our art: the first kind is common, the last rare. Neither of these is contagious, and I mention them merely to avoid confusion; they contrast strongly with the other cases, which can only be satisfactorily dealt with by scattering the patients. With many of these epidemics, though unmistakeably contagious, the ordinary forms of contagious fevers have nothing to do, and we can only conclude that germinal matter which was not contagious has become so by passing through the systems of the wounded and the puerperal. Not unfrequently also, it is found that some attendant has handled, either alive or dead, some patient with spreading inflammation. The danger of an accoucheur doing so has become notorious, and operators are also alive to the risk.

In different degrees the puerperal and the wounded, the latter especially, are more inoculable than the healthy. In the air cells of the lungs we have all liquor sanguinis exposed to the air, and ready to feed the floating particle which may develope in it. But a sore is a similar surface without the elaborate protection which shields the air cells of the lungs, and hence the necessity of the careful covering of wounds, even in spite of which the wounded often suffer from poisons which seldom affect the unwounded.

In some constitutions erysipelas arises almost as readily as catarrh, and to the wounded it often proves contagious, and the more so if it be of a kind which spreads rapidly over the skin of the individual first attacked—that is, if the germinal matter, the active agent in the inflammation, is of such a kind as readily to excite the same action in germinal matter with which it comes in contact, either in one man or in more than one. Whether, then, the germinal matter tend to rapid proliferation, to the extent even of obstructing vessels of some size, or to solution of formed material—that is, either to inflammation, sloughing, or ulceration—the more active it is in the individual the more it is likely to be contagious.

The principle is yet of wider extent; the experiments on the inoculation of tubercle have shown that the grey granulation which forms the most numerous centres in the individual, is also the most inoculable.

In syphilis it is found that the matter of a chancre which was not inoculable becomes so when the sore is irritated with savine; that is, when the germinal matter is caused to multiply faster, it becomes an inoculable contagion, when it was not so before.

Mr. Squire finds those cases of diphtheria to be most contagious in which the secretion is most abundant. (See article "Diphtheria," in 'Reynolds' System of Medicine.')

In severe epidemics of smallpox the average number of pustules in each case is far greater than in sporadic cases, and the contagion is more dangerous; that is, the germinal matter of variolous inflammation which has the greatest power of influencing other germinal matter in the same individual is also the most contagious, and this the more so because the faster germinal matter multiplies the more it is tenacious of life.

Conversely, smallpox matter, which when inserted locally in the human skin is able to establish new centres of action, and is actively contagious, when passed through the cow undergoes a change by which it loses at the same time the power of establishing new centres of action, and also its property of aerial contagion. We are entirely ignorant what change the matter has undergone, but we see that the power to spread from part to part goes hand in hand with the power to spread from being to being, and that when the one is lost the other is lost.

No inflammation flies more rapidly over the skin than that which is characteristic of scarlatina, and probably none flies more rapidly over the mucous membranes than that which accompanies influenza; and no two diseases are more diffusive.

But, it will be said, this is to destroy the distinction between inflammations and fevers: it is merely showing that there is an imperceptible gradation from one to the other. The local and limited is still an inflammation, the general and diffusive a fever.

The shut sacs, the serous and vascular, have also their spreading inflammations; and although these being closed cannot exhibit their contagion in the ordinary way, yet it is matter of common remark that they are peculiarly dangerous cases to examine soon after death; the dissecting wounds received in making them are often followed by a diffuse inflammation of a frightful kind, accompanied by immense formation of a low form of germinal matter. While I write the impressions of memory become vivid of comrades with whom one day I have joked and chatted, and two days later have laid open veins and arteries in the endeavour to secure for science some lesson from a sudden and irrevocable fate.

The property of contagion, then, belongs to inflammations as well as fevers—to the latter more frequently; the only way to understand it is to regard it an attribute of germinal matter.

We have next to consider whether we can find in inflammations any indications of local protective influence. Let us first recall to mind that common inflammation having neither specific nor spreading quality, once in a part tends to remain there while it lasts; and it is more likely to return to that part than to one which has not been affected; so that any indications of an opposite tendency are more striking as showing that some new principle is coming into play. Some annular affections of the skin, erythemas and erysipelas, spread much more readily towards skin which has not just before suffered than back again over that which has. Tonsillitis will often go from side to side, affecting each

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tonsil once. Mumps frequently takes the salivary glands in regular order. Some catarrhal affections of the mucous membranes show the same tendency. I think we may fairly conclude that in these cases the development of the germinal matter is different from that which it undergoes in inflammation which remains or recurs by preference in the part it has once affected. In some forms of erysipelas, of catarrh, and of mumps, contagion gives further evidence of a specific quality. The local protective influence may be quite transient, for after a brief interval catarrh and erysipelas show the usual tendency of inflammation to occur where it has occurred before.

Even in smallpox the protective influence of a previous attack is not quite absolute; in scarlet fever it is again less, but it is greater in these diseases than in any other; that is, the vitality of their peculiar germinal matter out of the body, which is the cause and measure of their contagious power, accompanies and is associated with a prolonged vitality or retention of its specific quality by the germinal matter which they lay down within the body.

In influenza, and I think we might say in typhus, the protection does not extend to another epidemic. The least specific inflammations or fevers allow the germinal matter to return earliest to its former state, the most specific effect the most thorough change and the most enduring, and with the strong individuality of this latter germinal matter goes persistent vitality, and therefore the quality of contagion. A specific development of germinal matter could never come to an end in the living body for want of pabulum; it may easily terminate from having leavened all that is susceptible of the change. It seems to be only in the very worst cases that all the germinal matter of the body is susceptible of the specific action.

CHAPTER VI.

SPECIFIC GERMINAL-MATTER DISEASES.

"Corruptio optimi est pessima."

I do not think that it is possible for any one to be familiar with the manner in which the textures either of plants or animals are developed from clear structureless blastema or germinal matter without coming to the conclusion that it is the most wonderful substance known. It is quite impossible to deny it to be the active agent in nutrition and growth, and we have now before us a class of diseases remarkable for the manner in which they influence and are influenced by nutrition and growth, and we ask the reader to place their cause and seat in that substance whose acknowledged qualities so far transcend any additional powers which we ask him to attribute to it. If a fever throws that material which usually repairs the waste of the textures into a course of development in which it does not do so, we can readily understand the emaciation which follows, not, be it remarked, during the height of the fever, but during convalescence, when the patient has already begun to take nutriment freely. But, not to anticipate, let us take the best known, the most typical of all the diseases of the class we are considering, smallpox, commencing with the lymph. For obvious reasons vaccine is preferable for examination, and I imagine that no objection would be taken to the substitution. Vaccine matter is perfectly transparent to the eye in the small quantities in which we see it; it hangs on the arm clear like a dewdrop; water containing the smallest animalcules only is also equally clear. Under high powers of the microscope Dr. Lionel Beale finds particles of germinal matter exhibiting very active movements, similar to the movements of like particles in pus and mucus. ('Micr. in Med.,' Pl. VII.) When this matter is inserted into a child's arm, in a week it multiplies a thousandfold; it grows, and that rapidly; we have abundant evidence of the activity of small particles of matter in a state of growth, and such particles are shown to exist in the vaccine. We have absolutely no evidence of the existence of any chemical poison in it, but living particles are found in all discharges known to be inoculable. Ordinary vaccine when introduced into the arm of an infant multiplies locally, forming a vesicle; but when the process is over we find that no texture of the body is the same as before as tested by vaccine or smallpox. No mere change in the fluids would account for this—the fluids are not the same for a month together; but let a change take place in the germinal matter of the textures brought about by the circulation of some of these living particles in the blood, and when once they have communicated their peculiar property it will be retained on the same principle by which the germinal matter of bone continues to produce bone. In many children the areola shows that the specific inflammation extends far beyond the pustule, and in some children many insertions are followed by a distinct rash, vaccine roseola and lichen; change the matter for that from a variolated heifer, and secondary vesicles are sometimes produced near the primary; change it for smallpox matter, and a few, or even very many new centres are established. To speak of the pustule as the only anatomical lesion of smallpox is to take a very limited view of the matter. Many physicians have long been convinced that the changes extend throughout the body; and this conviction would be much more general than it is were it not that there is a habit of calling the numerous changes found in the post-mortem room inflammatory complications, instead of regarding them as exaggerations of those changes which the germinal matter undergoes throughout the body in the ordinary course of this disease; close naked-eye inspection and handling of the textures show widely-spread alterations; and the microscope shows the changes in the capillaries to be almost universal. Smallpox, from the facility with which it is diagnosed, whether cases are slight or severe, is the best type of these diseases for study, and it gives good evidence that the germs may pass through the blood of an individual who has had it without causing symptoms. Dr. Madge in his work on the 'Diseases of the Fœtus,' and in papers in the 'Obstetrical Transactions,' has collected cases by Mead, Jenner, Montgomery, Ebel and others, which show that the fœtus may take the disease through the mother when she herself is protected; when it does so the fœtus suffers at a later period than the mother's attack and exposure, which period is of variable length, from one to several weeks. The French accoucheur, Mauriceau, took the disease in that manner. It would seem that a slight degree of protection is hereditary in many cases. Heim, Jay, and others have shown that at the earliest period of life a smaller per-centage of vaccine insertions produce vesicles than a little later, a fact analogous to the partial exemption of infants from other contagion. The facts suggest the idea of protection localised in the tissues, or rather in their nutrient germinal matter, and in proportion as that derived from the mother is exceeded by that which is superadded the protection becomes less. This local idea of protection makes it clear why a slight attack of natural smallpox confers something less of protection than a severe one, and inoculation something still a little less; it explains why the protection of vaccination is in some sort proportioned to the number and magnitude of the vesicles as determined by the scars—a fact brought out very clearly by Dr. Marson in the Reports of the Smallpox Hospital. Let us regard, then, every vesicle as the centre of formation of those little living masses found in the lymph, which will not only excite the same action in another subject, but which leaven more or less the germinal matter in the textures of the whole body, so that it is never quite the same again.

Next to smallpox, the best known of this class of diseases is perhaps the rinderpest—a malady most closely allied to the exanthematous or eruptive fevers of man; like cholera, it is from time to time imported into England, and no evidence has been found of its spontaneous origin in this country. On looking over the fine illustrations of the third report of the cattle plague commission, the impression is at once received that the disease went through the animals. The skin and hair follicles, the udder and teats, the nasal mucous membrane, the fauces, gums, and palate, the inside of the cheeks, tongue, larynx, trachea and bronchi, the œsophagus, all the four stomachs, the small and large intestine, the rectum, perineum and vagina, and even the interior of the heart and brain, all exhibit such a number and variety of anatomical lesions as should reduce to despair those who hope to understand and classify fevers by limiting their consideration to these effects, as well might one try to understand the causes of a great war by careful mapping of its battles and skirmishes. When we turn in the same report to Dr. Lionel Beale's microscopical researches, and look at the capillaries, the small veins and arteries obstructed with masses of germinal matter, we then see still more clearly how such a fever pervades all the textures of the body, as a widespread erythema or erysipelas does the skin. The increase of the white blood-cell and other masses of germinal or nuclear matter is noted everywhere, and towards the end he remarks:

"The changes of the germinal matter of the tissues generally in fevers precisely resemble those observed locally in inflammations. The local phenomena of inflammation precisely correspond up to a certain stage with the general phenomena of fever." Fifteen years ago, Dr. Hughes Bennet ('Leucocythemia,' p. 115) had arrived at the conviction that "we must ascribe the ultimate cause of inflammation to a derangement of those forces which regulate the nutritive powers of the economy." We must now do the same thing for fevers, and it is clear that those forces reside in the germinal matter chiefly, and probably exclusively. If we suppose all this germinal matter to multiply, and the products to be excreted when recovery takes place, we have no explanation of the non-recurrence of the disease; if we adopt what appears to me to be the more natural conclusion, that it resumes its functions of textural nutrition from which it had been temporarily diverted, still retaining in the textures its peculiar properties, some of its products only being excreted, we arrive at what I think is the only tenable conclusion, that the liability to the fever, the essential changes of the fever, and protection against its recurrence, all lie in the same substance.

Cattle plague is as inoculable as smallpox, and yet, like that disease, its contagion has been strenuously denied; it is not denied now. All the secretions of cattle plague are inoculable, and remain so after dilution with ten parts of milk. Vaccine will bear large dilution with glycerine, and so diluted has been extensively used at the Berlin Vaccine Institution, under the Director Müller, as well as to a smaller extent in this country. Looking at the facts of vaccination and inoculation, as well as the extreme variety of the lesions of cattle plague, it is probable that the infecting particles multiply locally in the first instance, either in the lungs or elsewhere, and then pass into the blood; there they may increase in size, but when they give rise to rashes only, it would seem that vessels are not entirely obstructed; in smallpox they probably attain a larger size, become little emboli, and stick in the vascular plexus surrounding the follicles of the skin, the nuclei, as Mr. Erasmus Wilson long ago pointed out, of the umbilicated pustule. The recent experiments of Villemin lead to the same explanation of the arrangement of miliary tubercle, and of the scattered tubercles of the serous membranes.

A thorough comprehension of the leading facts with regard to smallpox, both as it exists now and existed formerly, also of vaccination, and of cattle plague, is the best preparation for the study of those fevers which present greater difficulties of identification.

The general facts of scarlet fever and measles are similar to those of smallpox — the contagion, the protection; the rashes show that the skin is affected very unequally, and the symptoms, by their variation in the same and different cases, show that there is equal variation in the conditions removed from our view; delirium may, I think, be accepted as a proof of active changes in the germinal matter of the brain, in the nuclei of the cells of the grey matter, especially when we have regard to the tendency of this symptom to occur in the young, in whom the grey matter is in a state of rapid development; so also with those curious changes, more or less permanent, which the memory undergoes in some cases. Intolerance of light and sound, as well as the different affections of the eye and ear, which occur especially in scarlatina and smallpox, show that the nervous and other apparatus connected with these senses has partaken in the disease; the ulceration of the cornea in particular is a proof that the changes of the fever extend to parts not reached by the red blood. The suspension of the secretion of urine, the passing off of albumen and of epithelium from the tubules of the kidney indicate that the disease is active there. The desquamation of the skin, occasionally of the stomach (see a striking case cited by Dr. Beale, 'Micr. in Med.,' p. 194), the falling of the hair, in infants the production of teeth wanting in bands of enamel, show that other structures have participated; and the not unfrequent consolidation of nævi dating from severe scarlet fever, shows that morbid as well as healthy tissue may be included in the febrile action.

Discussion may very fairly arise as to what diseases should be included with the more typical ones we have already noticed; several others together with individual differences preserve a strong family likeness. Perhaps one of the most different from those we have been considering is syphilis, which I have no hesitation in adding to the class. While measles run the shortest course of any of these diseases, syphilis runs the longest; it has the general characters of the group, it is received by contagion only, it has a very variable and sometimes long period of incubation, it has an eruption, and its effects are least serious when this is encouraged by warmth to develope itself, and in warm climates. After several infections or syphilisations a kind of protection is obtained, perhaps rarely complete and durable if it were desirable. The eruptions, ulcerations, diseases of bone, gummata and waxy liver, together with its tendency to affect the eyes, to cause the hair to fall, and like smallpox to produce a species of phthisis, in the child the peculiar manner in which it affects the growth of the teeth, are also striking proofs of its pervading the whole economy. Perhaps syphilis is the most remarkable instance of the manner in which the influence of these diseases passes through the germinal matter of the ovum or spermatozoon to the fœtus, the slowness of its course giving ample opportunity for it to do so, and for its effects to be observed. The morbid peculiarities which either parent may transmit to the offspring are almost as numerous as the differences of races, families, or individuals. On the interesting subject of hereditary proclivities I must refer the reader to the 'Medical Notes and Reflections of Sir Henry Holland,' chap. ii., whose general conclusion is that "every part is susceptible of deviations from the normal type or natural structure capable of being conveyed to offspring." Now, the germinal matter is the only substance through which these peculiarities can be transmitted, for there is no continuity of formed material, and that being so, its own peculiar morbid states could scarcely fail to be also conveyed. From many sources evidence can be adduced to show that acquired peculiarities are transmitted to the offspring as well as hereditary ones. In inherited syphilis there is as little advantage in supposing a separate soluble chemical poison to exist in the infecting spermatozoon or ovum, as there would be in supposing such in order to explain hereditary obesity or gout.

Diphtheria has the general characters of the class, with perhaps a special tendency to affect open sores, and to produce a peculiar kind of paralysis, something like that which follows poisoning by arsenic; but most fevers when very severe occasionally produce such effects. The contagion of this disease is sometimes spoken of doubtfully, and even denied: if the frequent disasters to medical men from the injudicious practice of applying strong caustics instead of soothing applications to the throat have not induced a more correct judgment, the recent death of Dr. Weber, of Heidelberg, and two assistants from sucking out the opened trachea of a diphtheritic patient, should lead to a sounder and safer doctrine.

The poison of typhus seems to be readily produced by overcrowding, in which respect it resembles the hospital poisons we have before spoken of. The protection this disease confers often does not extend to other epidemics; it has perhaps a special tendency to affect the brain, but there is ample evidence of its all-pervading character.

Typhoid or intestinal fever is marked by a very low degree of contagion, very much like that which secures a belief in the contagion of phthisis in Italy, the coincidence being the more remarkable from the close resemblance of the typhous deposit to certain forms of tubercle, as well as the occasional likeness of the symptoms. The relapsing fever seems to resemble syphilis and, perhaps, influenza in the facility with which its processes may be suspended and again renewed, or, we should rather say, may be so modified as to suspend or renew serious symptoms.

Yellow fever appears to me to belong to this class, its poison tending specially to affect the liver, its destructive influence on the blood producing black vomit, it shares with other fevers in their later stages and most malignant forms. Its protective influence is very decided.

Cholera, I believe, belongs to this group, but as there is at present a strong disposition to attribute this disease to a vegetable cause, and the case as well as that of influenza is peculiar, I reserve a few remarks on them for the eighth chapter. In this disease, as well as in the recent epidemic of malignant purpuric fever, the difficulty in tracing contagion is aggravated by overlooking the slight cases to which I have adverted in the introduction. The worst forms of both are little more than modes of dying, the essential changes of the fever dating some hours or days before the symptoms.

Plague also was a disease whose course was frequently wellnigh run when the plague spot appeared; in London it was always accompanied with a great mortality from other fevers no doubt due to the same poison; it seems to have given about the same amount of protection as typhus.

The black death, the sweating sickness, and other epidemics of the middle ages, must be added to the list, together, I believe, with influenza, the prevalence of sneezing in this complaint much favouring the wide diffusion of the poison; and this, as usual, has caused the facts of contagion to be overlooked.

The rule with germinal matter poisons is that their effect is confined to one species, but there are many exceptions, and without the study of these also we cannot hope to fully understand epidemic disease. Various ruminants are susceptible of rinderpest inoculation, perhaps all; while man, the horse, and dog are not, but the accidental inoculation of Mr. Hancock's hand (see 'Cattle Plague Report') shows that considerable local action may follow; it was not determined by inoculation whether specific matter had been reproduced; if it were, this would not be without a curious parallel. It is said that the old inoculators of smallpox sometimes kept up a supply of matter on their own arms. The variolation of the cow and the vaccination of man show that poisons may pass to the most different species; glanders shows the same, so also rabies; this disease is remarkable for its tendency to lie long inactive in the tissues before it commences its general action. Authentic cases extend this period from two weeks to two years; the conditions of the wound appear to influence the length of time. The syphilitic poison has certainly the same power of lying *perdu* in the tissues. I would here remark, *obiter*, that arguments against contagion often presuppose the absence of this power of latency. The inequality of the period of incubation of other contagious diseases, deduced from crucial circumstances by different observers, shows that other poisons have more or less of the same power. Dr. Scott Alison has recorded a case in which he is convinced that vaccine lay long inactive in the tissues; many insertions of the matter had been made without effect: when at length the action began it ran its ordinary course. Attention has not, I think, been directed to this, delayed vaccination being generally treated as delay in the development of the vesicle only. Jenner was aware of the effect of other diseases of the class in suspending development, a further strong argument that their seat is in the same material.

Hydrophobia is so rare and so fatal that we are not likely to know whether man can suffer twice, and animals are usually killed,—but all animals are not susceptible of it. Dr. Gamgee ('Reynolds' System of Medicine,' p. 717) quotes the case of a pointer bitten purposely seventeen times, which did not become rabid. I cannot find any account of an infant or a puppy suffering. The poison of the South African tsetse, which has some curious analogies with rabies in its deferred effect, and in being apparently received from a species so different, seems not to affect calves. Is this poison secreted by the fly, or does it merely carry it from other ruminants?

CHAPTER VII.

MISCELLANEOUS.

"Quâ via difficilis."

THE warmer countries and denser masses of men, or perhaps those whose sanitary condition is most execrable, seem to give rise to the most exceptional varieties of germinal matter, the most active, the most contagious, and the most tenacious of life. We have seen (chap. v.) that in its passage through the system germinal matter is influenced by the state of the health; it admits of easy demonstration that under very bad sanitary condition particles from the bodies of others will be more frequently received into the body either in food, water, or air, that being received for the most part sooner than in a better sanitary state, they will be in larger proportion living; in the tropics, too, where air and water are often not far removed in temperature from the human body, fewer of the living particles will be killed in passing from individual to individual, so that those exceptional conditions requisite to give rise to the more permanent poisons are there more likely to be fulfilled. In a hot glass manufactory the tube of the glass-blower is said to carry the syphilitic poison. We do not hear of its transmission elsewhere by common use of drinking vessels, pipes, or musical instruments. In India, and, as lately pointed out by Dr. T. K. Chambers, in Italy also, morbid processes are more active, they tend to be acute rather than chronic. This energy of action may even render disease contagious which would not have been so in this climate on the principle before referred to, that the discharge of the chancre irritated with savine is inoculable, when previously it was not so. Since contagious surgical and puerperal fevers, contagious hospital erysipelas, pyæmia, and gangrene are so readily reproduced that the difficulty of prevention has made it a special study, we may fairly ask whether other maladies can thus be produced. A curious contagious disease is recorded by Huxley to have arisen on board the surveying vessel Rattlesnake, characterised by glandular and diffuse cellular inflammation by common and phlegmonous erysipelas and mumps. Other instances are scattered in medical writings. But can scarlatina, variola, and cholera, can the best marked and most permanent types of contagious disease, arise spontaneously? It is certain that if they do so it is under circumstances which fortunately are rare. On the germinal-matter theory we are no longer under the necessity of supposing a creation of living matter, but merely a series of changes in the properties of existing germinal matter placed under new circumstances, and I think it would at present be well to consider the matter open.

The germinal matter of the nucleus of the cancer cell is highly specific, that is, it tends to grow in a manner far different from the nuclei of the healthy body, and yet in some men whom we cannot call other than healthy the irritation of a claypipe to the lip, or of soot to the scrotum, will cause epithelial cancer, and the secondary deposits may be scirrhus or medullary. What is that but the creation of cancer? The nature of the irritant seems to be less important than the duration of its action. I have the history of a case of urinary fistula of twenty-one years' duration, in which for many years all treatment had been refused, the urine being passed through the scrotum by numerous fissures, in which cancer was suspected; the patient died worn out, and all the characteristic appearances of epithelial cancer were found on microscopic examination of the indurations.

Prolonged pressure, too, brings healthy epithelial growth to the verge of disease, as we see in callosities and corns.

Everything in nature has its use, and the use of the specific germinal poisons appears to be to weed out crowded species, and to leave room to the survivors for life and enjoyment. If the idea shocks, it is part of the same plan of creation as the tiger's tusk and serpent's fang; accordingly, they act most on the species from which they originate, *similia similibus* (pardon me, I am perfectly orthodox). The rule is, then, that human contagions are most dangerous to man. The dissection of recent human bodies is more dangerous than that of recent animal bodies. Man takes the diseases of animals with difficulty; but men suffer from some animal contagions, and under certain circumstances others might be transmitted which are not usually so. In fact, it is requisite that the diseases of animals should be studied as they have not been studied yet; many points can be readily determined experimentally on them which could not otherwise be determined at all. Throughout history, ever since the plagues of Egypt, there has been a remarkable coincidence of epidemics and epizootics. The possibility of the infection of man from animals should not be lost sight of. Many of the apparent origins of epidemics affecting one species may be mere instances of transference from some other.

It must be remembered that men who are not ill, or scarcely so, may reproduce a virus, as we see in vaccinations, some inoculations, and cholerine, just as among the truly parasitic diseases a few trichinæ may be developed in a "host" without symptoms.

During epidemics medical writings teem with the assertion that besides the cases which can be considered to belong to the prevailing malady the symptoms of other diseases are modified, and slight effects are produced on the healthy; thus, sore throat, when attending scarlatina, looseness of the bowels during cholera, and debility during influenza epidemics, are recorded far too frequently to be attributed to fear, and the modification of the symptoms of other disease, as, for instance, the occurrence of purpuric spots and boils, cannot be so explained at all. Taking such facts as these in connection with those in the second chapter, we may conclude that the morbid poison when epidemic disease is prevalent is far more widely diffused than is generally supposed, that nearly every one breathes it; those who receive the poison in this way should attain a certain protection, and there is some evidence that they do so, for it is notorious how liable to suffer are those who have been brought up in a pure air on first taking to ordinary town life, and how fatal are epidemics when they reach lands which have been preserved by isolation; thus, in 1707, Iceland lost one fourth of her population from smallpox. On this view, then, acclimatisation to any particular fever without an attack of it would have an analogy with inoculation. Others would explain the phenomena of acclimatisation, as also the fact that the severest cases of an epidemic are often the earliest, by the removal from the race of its weakest members something in the order of their predisposition, and by the destruction of individuals, and the consequent change in the race, would explain the different effect of the same disease on different races. While fully recognising the great weight of these latter considerations, I think the former kind of protection is seen in the aged and in the inhabitants of unhealthy towns more frequently than mere selection would account for.

Different poisons are differently affected by different meteorological conditions, probably within rather narrow limits. Some years ago, I commenced a series of tables, of which a few were published in the 'Medical Times and Gazette,' 1857, which would, I believe, have gone far to determine this matter, but I was obliged to relinquish the subject; my conviction of its importance remains still unshaken.

It is difficult to distinguish an influence affecting the vitality of the poison from one affecting the predisposition of individuals to suffer by it, but it would seem that while some poisons can be widely diffused by dry air others prefer damp. I have noticed the special power of the dry east wind to take up and carry solid particles, and the spread of cholera and influenza during these winds has sometimes been very remarkable. Where this wind comes overland, as it does to us for the most part, it takes up with moisture solids which, whatever their nature, appear to be at least sometimes deleterious. When the air is loaded with minute morbific particles a heavy rain produces a diminution of disease; instances of this are very marked in the cholera charts. To this purification of the atmosphere, as well as to the mitigation of extreme temperature, is due the healthiness of London in some summers and winters of exceptionally frequent rains. A damp atmosphere seems more favorable to the vitality of the poisons of scarlatina and smallpox; the former prevails in damp seasons, new houses, and after inundations; while smallpox epidemics on the African coast have been cut short by the dry hot Harmattan.

Absorbent soils have long been recognised as more healthy, and recently Dr. Buchanan finds that drainage specially reduces the prevalence of phthisis; excrementitious matter on the surface of such soils will disappear on the first rain, while on undrained clay, for instance, fine particles of them may again rise in the air when heat evaporates the water of surface-pools or ditches.

The influence of level is often strikingly seen in different epidemics. I may instance specially cholera and cattle plague; though there are some sources of fallacy, they are insufficient to vitiate the conclusion that the poison has a specific gravity greater than that of air. Pasteur found the different minute organisms which abound in the air to diminish on ascending the Alps and Jura. His results were confirmed by a commission of the French Academy. No one who has watched from an eminence an ordinary grey mist settling in the calm air to the lower levels will doubt it. On the Himalayas cholera has been carried to the height of five or six thousand feet, perhaps it might be carried higher, but we must remember that wheat grows on the Himalayas at ten thousand feet, and the disease exhibits a most evident partiality for the plains.

Density of population has a weighty influence.

If particles were diffused into the air equally from a point, their chance of being taken up by the mouth or nostrils would be as the square of the distance from the point. In a large hospital ward with still air, two patients lying two yards and eight yards from a patient with typhus, the predisposition being equal, the nearer would be not four times, but sixteen times more likely to receive an effective dose of the poison. We see the influence of proximity on epidemics among animals and men; take of each a series of three: bees in hives, sheep in flocks, and animals scattered; a crowded ship, overpacked houses, and single dwellings; and are not the epidemics in rough proportion to the crowding?

Let us devote a little attention to causes determining the distribution of the eruption, such as cold. Given, masses of germinal matter circulating in the blood and undergoing their peculiar development, it is obvious that anything which alters the proportionate size of the vessels will alter their distribution; when a scald, a blow, an inflammation has enlarged the vessels of any part shortly before an attack of smallpox, that part gets more than its share of vesicles. In particular, warmth to the skin enlarges its vessels, and tends to allow the germinal matter to undergo its peculiar development there; probably the effect of long-continued cold is actually to squeeze from the contracted vessels the soft germinal matter into the circulation, a kind of metastasis quite independent of the excretion of any poison from the body.

Causes that weaken predispose to many of these diseases—such as famine, long fasting, diarrhœa. The latter seems specially to facilitate the invasion of cholera; in some cases it may be an earlier symptom of the disease itself, but it is generally believed, with reason, that there is something more than that. It has been very plausibly argued that the primary seat of action of the cholera poison is on the mucous lining of the small intestine. Whether it be swallowed with water or food, or be breathed, and striking on the back of the pharynx adhere, and be afterwards swallowed, which probably occurred at Southampton to the farmer of Thoydon Bois; in either case a feeble gastric juice, absence of bile, or rapidity of transit through the stomach, from that increased peristaltic action which accompanies the nausea of autumnal diarrhœa, may easily determine its arrival in the small intestine with undiminished vitality and morbific power.

The particulars of the cholera outbreak just referred to are peculiarly instructive; usually cholera has commenced in England after affecting the German ports, and our east ports in communication with them have been the first to suffer. But in 1865, the German ports were not affected, but there was a severe epidemic at Gibraltar, from which frequent steamers make the passage to Southampton in four days. Thoydon Bois is naturally one of the healthiest spots in England; the house was comfortable, but the water in the well was contaminated by the cesspool, and for some time the farmer had had occasional diarrhœa; he had gone to Weymouth and returned through Southampton, just after the earliest cases of cholera had occurred there; his illness contaminated the well, he died, and was the cause of several deaths, including that of his venerable medical attendant, Dr. McNab. At this time England was elsewhere free from cholera; those who deny a cholera virus must find it hard to explain the story.

All fevers undergo more or less of modification in subjects suffering from other diseases, especially those which injure the quality of the blood; typhus, for instance, is modified in patients with liver disease and in those under malarious influence; this must not be confounded with change of type. Scurvy has been assigned as the cause of purpuric spots in some so-called typhus fevers, rather than change of type; the distinction will be arrived at by extending the range of observation. Most of our epidemics are common to large masses of population, under very varied conditions of diet, while scarcity of vegetable food is local, and often confined to one class.

Ozone is supposed to destroy these poisons; there is, however, great doubt resting on the history of that substance; the ozone air-tests usually act nearly in proportion to the amount of air which passes over the papers in a given time, and perhaps it would be better to say that, in the slow combustion of impurities in pure air, the oxygen if in rapid motion is as much more active than oxygen at rest as it is in ordinary fire, possibly in both cases the correlatives motion and chemical force being converted.

CHAPTER VIII.

CONTRASTS.

"Ferte arma."

To determine the animal or vegetable nature of cells detached, or nearly so, whose history is not very fully known, is a task of extreme difficulty. Among larger organisms mere vegetable form with fixed root and even an apparent fructification is not enough, we see that in many of the polypifera such as the sea-lilies, true animals which feel, and choose, and swallow; and it is quite common for marine specimens of considerable size to be collected among plants which are really animals. If this be the case, what wonder that among the cells of discharges of different kinds from the human body there should be difficulty in determining whether they are animal or vegetable. The discussion of the matter would be of very little use, for it does not appear possible entirely to separate the two kingdoms of nature.

The skin gives a good opportunity of observing the nature of the difficulty. The reader may compare Mr. Erasmus Wilson's opinions as set forth in his 'Phytopathology of the Skin,' and elsewhere with those of Dr. Tilbury Fox in his 'Skin Diseases of Parasitic Origin.' The former considers the vegetable-looking productions of tinea and favus as "aberrations of cell formation," consisting "in the growth and proliferation of the primary granules of which epidermic cells and hair-cells are normally constituted;" the latter in very beautiful drawings shows them as fungi with all the appearance of separate existence. Quite appreciating the difficulty I am content to state it, and to admit that between the causes of the malarious and contagious fevers the difficulty is likely to remain at least as great. I do not think that the principles which should guide the decision have yet been satisfactorily laid down; in the meantime I think it best to call organisms multiplying only in the human or animal body and retaining life in discharges, and forming therefore a real contagion, such as the living particles of vaccine, as animal, and those which, taking their origin in marshes or unhealthy soil, affect those exposed to the air of such localities, and do not pass on to others, as vegetable. The favoured habitat of the one is the crowded city or densely-peopled land; of the other, the mangrove swamp, the jungle, the marsh, the torrent-bed, or along wooded rivers; it may be

> "Where human foot hath ne'er or rarely trod."

Thus attributing, as is now generally done, ague and the other malarious fevers to fungi or confervoid plants like the palmellæ, whose little spores, we might perhaps say whose little selves, rise into the air in enormous numbers with the watery vapour, when the sun acts upon the marshy soil or malarious silt at a certain stage of desiccation, the malaria, the bad air, is simply air in which these are more or less diffused. With the evaporation of water such small bodies rise into all the lower strata of the air; towards evening, when the lowest strata are cooled by their proximity to the earth, itself cooling by radiation, the globules of water as they condense attract all the fine solid matters suspended and bring them down nearer to the ground, so that the mist of evening contains more dangerous matter than the clearer air of the day.

It would seem that these spores, as they exist in the most deadly malaria, grow, and that with great rapidity, on the membrane of the capillaries of the air-cell, passing from time to time into the blood. This theory of ague gets rid in great part of a puzzle of antiquity—the cause of the periodicity of ague, which is brought under the known laws of the periodicity of vegetable development.

A little explanation is here necessary. Philosophical botanists tell us that plants, with all their exquisite variety of leaf and flower, consist merely of the axis and the appendage of the axis. The simplest means are thus made to attain results of surpassing beauty. The plan of the vegetable is alternate free and restricted cell-development. This law extends to the lowest forms. Those plants which are mere cells do not develop uniformly, but with alternations of free and restricted growth, and this is so quite independent of light or darkness, damp or drought, heat or cold. So that when we find the symptoms of ague to be intermittent, and contrast them with the continuous development of the germinal-matter diseases, we have confirmatory evidence of vegetable causation.

Fortunately for the human race quinine, while harmless to man, is fatal to these minute organisms. Small doses of arsenic have a similar effect. The symptoms differ from those of the contagious fevers in the absence of rashes, there is evidence of obstruction of the circulation, but not of that erythematous condition of the skin or mucous membranes, which so many of the contagious fevers exhibit; the one disease is truly in the blood, the other in the germinal matter of the tissues more than in the blood.

Against the malarious diseases there is no protection acquired, as may be seen in the peasantry of the Roman campagna. So far from an attack proving protective against further attacks, aguish symptoms affect those who have suffered from them years after, often when they have removed to a healthy country.

We have reason to attribute ague and the other marsh fevers to vegetable origin, and we find that they have the following character: they are local, they are not contagious, they leave no protective influence behind, rather the reverse; they have no rashes, and do not show that intimate association with nutrition, they do not produce that sudden emaciation which we have seen in the acute specific diseases of the nutrient germinal matter of the body. In the tropics only, where malarious fevers and contagious fevers prevail together among a population in wretched sanitary condition, there is difficulty in distinguishing the severest cases of contagious yellow, and probably other fevers, from malarious fevers. This is not surprising, for in this country the severest cases of several fevers, whose fundamental difference is fully admitted, are quite similar; the true malarious disease, however, is plant-like, *adscriptus glebæ*, and does not travel to any extreme distance like cholera or yellow fever. When cholera is attributed to a vegetable cause one naturally asks, Can we suppose a vegetable to flourish equally in the damp heat of the lower Ganges, in the dry heat of Mecca, in the cold of St. Petersburg even in winter, in the salt air of the mid-Atlantic, and the saltless air of central Europe? We know that the human body and vaccine (human germinal matter) can do so. The true vegetable never goes far from its native soil, cholera cares little for distinctions of soil, it has never been more terrible than in crowded vessels at sea; whatever we call its cause the habitat of that cause is the human body. Air and water carry it for short distances, but man alone has carried it across the wide ocean.

Much attention has been recently directed, by no means for the first time, to fungi as a cause of cholera. There is an abundant development of animal and vegetable life wherever there is free organic matter, much more than is generally imagined, and this constantly leads to error. Nearly all animals are full of entozoa; an epidemic assails any species, the cause is sought post-mortem, the entozoa are found, and the finder shouts eureka. The potato, the vine, the hop, the London elms suffer, and aphides, scolyti, fungi, and other parasites abound. Without denying to these some effect, the facts show that the prime cause is the weakness of the nutritive forces of the individual, and that the parasitic animals and vegetables are the accidents. In man, the discharges of the skin or neglected sores, the fluids of the mouth, the fur of the tongue, vomited matters, the expectoration of phthisis, fæces, urine, even in the tubes of the kidney, discharge from the ear, all develop fungi. There is really little evidence of their having active properties; the poisonous fungi do not act in very minute doses, and I think the symptoms of ague may be successfully explained by their presence as extremely minute foreign bodies in the blood. Let the reader compare the early symptoms of extensive superficial burns and scalds, where blood damaged by heat has passed into the circulation, with other cases in which there is reason to believe that there are foreign matters in the blood, such as the shivering at the onset of smallpox, or before the formation of large abscesses; also the phenomena of pulmonary and other hectic; and, lastly, those produced by injecting minute foreign substances into the blood; and I think he will come to the conclusion that the mechanical explanation is more probable than that which would attribute to these little vegetable organisms effects to which there is no parallel in nature.

Cholera, like yellow fever and plague (see charts of the 'Report of the Registrar General on Cholera, 1849'), seems to require a certain duration of previous warmth to bring it into activity; some may consider this to favour its vegetable origin; it proves only that the vitality of much of the poison is destroyed by cold. The new fungi will probably be found after a time in other diseases, or in harmless fluids, as has happened before, and cholera will remain classed with the eruptive fevers, but with its eruption internal. Shall we attribute cholera to any of the smuts or moulds of rice? Rice is exported from India to all lands: is cholera exported with it?

Catarrh has been attributed to vegetable organisms. We must first subtract all cases depending purely on cold, checked secretion, gouty or other diathesis, and I think also the severer epidemics. These large deductions having being made, there is no reason to doubt vegetable influence, especially in spring catarrh. In May and June many tons of pollen alone are thrown into the air, and this is known in some individuals to cause the severe symptoms of hay asthma, and in others is no doubt the cause of slighter ones. From such symptoms those of the severest epidemics materially differ, and I cannot help thinking that the phenomena are those of an animal poison, though the case is a doubtful one; in fact, it is very difficult to say what should be called influenza, and what not. We must expect doubtful cases for the following reason, if a very fine substance, capable of causing irritation, be diffused in the air, if it affect with catarrh a large number of persons, causing severe sneezing, fine particles of mucus with germinal matter are thereby diffused; in this manner the diffusion of measles has occurred after breathing harmless dust, just as the syphilisers have found that irritation of a chancre will render it inoculable when it was not so before. The epidemics of influenza are often at long intervals; an attack appears to have a protective influence in the same but not in future epidemics.

In the case of a disease conferring no protection, the difference between the fungoid theory and that of Dr. Lionel Beale would not be so very great; it would be a verbal strife as to the animal or vegetable nature of simple organisms of the lowest class, a contest of little or no interest. They would both be germinal-matter theories, for it seems admitted that the vital action, the growth of the yeast plant, determines the saccharine fermentation; it cannot well be denied, for the embryos or buds of a great number of plants lie for months or years in the starch of seeds and tubers without affecting it till they begin to grow, when they change it immediately into a saccharine fluid. It is when we attempt to account for the protective influence of an attack that the weakness of these theories becomes conspicuous. The different forms of the doctrine of ferments, chemical or other, admit of being assigned to two heads.

1. The ferment changes something existing in the blood into fever poison.
2. The ferment, the fever poison, destroys something existing in the blood, its pabulum.

Now, as these somethings must be different for each disease, for one has no protective influence against another, it follows that for each disease two unknown substances are assumed, the ferment and the thing fermented, and this, I think, should be fatal to the theory. The same difficulty attends the animalcule theory, unless the term be extended from its usual limits of meaning so as to include such objects as the white corpuscles of the blood and all masses of germinal matter; in that case, the difference is verbal. The fungoid theory gives no explanation of the difficulty of transferring a disease from one species to another, together with its occasional possibility, or of the mutual influence of nutrition and fevers, nor, unless the fungi vary, of change of types. Some think that it is requisite to assume the poison to be sometimes active and sometimes inactive, that there is a sort of ripening of a spore; while admitting this to be worthy of consideration, I think that different degrees of liability and protection, together with the accidents of the particle, are quite sufficient without it, and indeed most fevers known to be infectious at all are so at all periods when once they have been fully developed.

To limit the contagion to any one medium only, as, for example, in the case of cholera to water or subsoil water, is to introduce unnecessary difficulties; when cholera breaks out in a country previously free from it, immediately after the arrival of infected ships, or when the disease goes with dirty linen to villages on the mountains, such limitations fail.

We have no evidence of mere decomposing matters causing specific contagious disease; that they cause disease, as, for instance, diarrhœa, we know by our dissecting-room experience. Such effects, as well as those resulting from the absorption of putrid liquid matters in surgical and puerperal fevers, quickly cease when the cause is removed. When these fluids carry with them solid matters either dead or living, as bacteria, for example, they are far more injurious, but no putrid matter approaches in concentrated activity the poison wounds received from recent human bodies after systemic death, but while germinal matter remains still living.

It is the true interest of science at all times to keep the line which separates the known from the unknown sharply defined. Surely this principle is forgotten when so evident a growth as the smallpox pustule is attributed to highly complex albuminoid matter in a particular state of decomposition. As yet the phenomena of growth, even in its simplest forms, are untouched by modern chemistry. Nay, more, while we have some evidence of the correlation of nervous and muscular with chemical and other forces, we have no evidence of the correlation of these forces with growth; and, therefore, to attribute inflammatory and febrile diseases, in which germinal matter grows as evidently as in the development of any texture whatever, to chemical forces, is at present quite unwarrantable. It is, in fact, an exemplification of that little foible of some chemists—it is not a new one—which suggested to Goethe the singular conception of Homunculus in the bottle:

> Was man an der Natur Geheimnißvolles pries,
> Das wagen wir verſtändig zu probiren,
> Und was ſie ſonſt organiſiren ließ,
> Das laſſen wir kryſtalliſiren.

Are these poisons gases or volatile liquids? Between these there is no real difference; hydrogen is simply the vapour of the most volatile of liquids. I have devoted the second chapter to meeting the difficulty out of which I think this theory sprang. Influenza is the most diffusible of diseases. In 'Reynolds' System of Medicine,' p. 36, Dr. Parkes gives brief but conclusive reasons why its cause cannot be a gas. In fact, on this theory, the eccentricities of epidemics, which present no difficulty at all to any one who will shape in his mind a few probable histories of solid particles in air or water, &c., become totally inexplicable, for gases are not slow in obeying the laws of diffusion as set forth by Dalton and Graham; like spirits

> "When they embrace, total they mix."

Again, these poisons multiply somewhere; do gases multiply? If absorbed into the blood they would be again exhaled, unless their action were immediate, which it is not. That a simple substance would be poisonous to the required degree is very improbable, and all known complex organic matters decompose when the attempt is made to vaporise them. But it may be said, we handle syphilitic secretions or vaccine matter without being syphilised or vaccinated, but if we handle smallpox matter we may take smallpox: is not the latter, therefore, more volatile? There is no reason to think so. In their chemical constitution no difference is known; they all burn rather than vaporise; the fine solid particles of the one are as likely to be diffused in the air as of the other, but the difference is at once accounted for if we accord, as we have grounds for doing, a more persistent vitality to the variolous particles.

A delicate nose at once detects the difference between the odours of the ammonia and sulphuretted hydrogen of the laboratory and those of decomposing urine and fæces; the latter produce, when powerful, a sensation of deadly sickness, which from the former is entirely absent. The odour of the gases may well be useful in directing attention to air likely to contain more dangerous matter. But some of the organic poisons seem to have a slight odour of their own; a peculiar smell attends cases of smallpox; near the northern outfall of the sewers of London one of the most horrible of instinctively so-called "faint" odours may be observed when the smell of no particular gas is recognisable. Such air must be dangerous: when we are told that the workmen do not suffer, it is forgotten that they are probably far less sensitive to such air than other workmen, or they would not have been tempted into the employment.

Though great confusion results from considering the organic poisons as gases, their exceeding minuteness must not be overlooked; from observation of the processes thrown off by pus-corpuscles Dr. Beale calculates that independent vitality may be preserved in masses from the 50,000th to the 100,000th of an inch in diameter; let us realise the figures, if such particles were placed in line in close order, a rank of one inch would more than suffice to give a particle for every death by cholera in

England in our worst epidemic, that of the year 1849; probably far more than one such particle is required to infect most men, but, however that may be, the whole line would be entirely invisible in the air, and an unlucky inspiration might in a moment engulph it unconsciously in the lungs of a single individual.

The actively moving particles seen in vaccine would average about 25,000 to the inch; no wonder the lymph is clear and limpid to unaided vision. The active particles in the lymph of a phagedænic sore are also so small as to leave it transparent.

Those who are most conversant with nature well know how wonderfully prodigal she is of germs of different kinds; the rule is that they are lost and die, the exception is preservation and life, just so it is with the germs of contagious disease. If these are so abundant, I have been asked, how is it that any one escapes? First, very little of the living germinal matter will reach its destination living, next the fluids in which it may alight living may not be able to sustain its life, and even if so the germinal matter of the body with which it is brought into contact may not be susceptible of its influence, so that the particles that infect will be very few in many myriads. If the reader has not directed his attention to the effect of a similar series of chances, I would ask him to look at the account of the bombardment of a town from a distance, and therefore practically without aim, and he will be astonished to find how few are hit. This applies only to the case of poisons diffused in limited amount and for a limited time, in which case the chance of escaping a sufficient dose is very considerable, but if the poison be diffused again and again, or in very large quantity, or among a population much predisposed, then few do escape, as is the case with measles, in former days with smallpox, with influenza, or with typhus in a dense, starved population.

Once more, are the contagious poisonous matters formed in the chemistry of animals analogous to the alkaloids produced by plants? This hypothesis is liable to the objection before stated, that it requires the assumption of two unknown substances for each disease, for it will not be supposed that the alkaloid produces itself, acting both as ferment and product of fermentation; the alkaloids, too, are soluble, and when taken in doses not immediately dangerous are thrown off in the secretions or oxidated in the blood, and the most poisonous of them, aconitina, does not approach in activity the poison of smallpox. The superficial observer may easily imagine that there is an analogy in the effects of the virus of disease and the poisonous alkaloid, but the physician accustomed to note the symptoms produced by both, and to examine with eye and microscope the tissues of the dead, will place a great gulf between them.

I had intended to have noticed some other theories of antozone, negative electricity, and such like, but after several attempts to do so seriously I relinquished the idea, I beg pardon for adding

"Multo non sine risu."

Survey the broad face of medical literature, and attempt to explain the facts there recorded without recognising the importance of active living matter, its continual dispersion, its frequent reception, its occasional and varying activity, and the attempt will fail. You have catarrh sometimes going through a house, affecting new arrivals, or becoming an epidemic —influenza, sufficient to suspend public business, even prevailing so that scarcely an individual escapes, and not always with small mortality. Again, take the prevalence of boils, as was the case a few years ago, or of purpuric spots at the present time, or of unnamed groups of anomalous symptoms, such as every physician knows that he and his brethren have met at the same time. Or take the typhus, typhoid, relapsing group of fevers, varying in intensity in different epidemics, from that of the Black Assizes, or the plague, to febricula. Take scarlatina, with its diphtheritic, ulcerative, and rheumatic variations; cholera shading off into rice-water purging; and so forth. But it is needless to multiply instances; the anomalies are well known, the diseases which are not described, the diseases which are described, but which will not conform to the descriptions, or not long. How seldom is it acknowledged that the descriptions are but the descriptions of types, that round the umbra of each disease there is a broad penumbra continuous with that of other diseases, and that the succession of disease is not the succession of absolute identity, but merely of similarity, though tending to conform to certain types. But recognise the importance of germinal matter as pointed out by Dr. Lionel Beale, and fresh light is thrown on pathology; recognise that the succession of this germinal matter need not be that of identity, but only of similarity, itself being descended from matter not having poisonous properties, or in slighter degree—that it is given off in all states short of an ideal health seldom if ever long maintained by men or animals—that its particles surface-dry can float in the air, are breathed frequently and much more frequently when the sanitary condition is bad,—make reasonable allowance for the influence of bearers, clothes, ships, or individuals, currents of water or air, and the difficulties in accounting for the transmission of the best-marked types of disease disappear, and also the difficulties of new diseases, of varying types of old diseases, and of unclassified forms.

CHAPTER IX.

CONCLUSION.

"Desine plura."

While it is good that we give ourselves to the study and observation of details—for without this there is no sound basis for general principles to rest on—it is also good that from time to time we take a more general survey of a wider field. The enunciation of the doctrine of germinal matter as an agent active in disease as well as in health, being of such importance that there is no branch of medical or surgical art on which it has not important bearings, furnishes a good opportunity for such a review.

Except in as far as was necessary for illustration, we have confined our attention to a group of diseases which, though in some respects widely different, form a natural family, and in the present state of medical science will be more readily comprehended if studied together than separately. The subject is a fertile one, and deserves much careful thought and discussion, in which different minds may correct each other's defects and bias. In the hope of creating a more general interest in the matter I have written this book, and now, in closing, it will be well to cast back a glance at the doctrines it contains, and see what is their practical bearing. They may, perhaps, be called contagionist doctrines. Now, such have certainly been, and in some countries still are, the source of very absurd practices in the matter of quarantines, but these doctrines are not what would be popularly understood as contagion, if the word were used without explanation, and I think there will be found no real arguments for quarantine in the facts here adduced; the common-sense conclusion is that the sick-room, being the manufactory of the poison, is the place to destroy it by cleanliness, ventilation, and disinfection. The 'Lancet,' in the notice it kindly took of the first edition of this work, justly remarked on the importance of these views in preventive medicine. If there is hesitation or doubt as to the existence of a poison in or about the sick, the very motive and object for special cleanliness in the sick-room is lost, and a hazy notion of its general advisability will ill supply the place. Allowing for exceptional cases, quarantines depend on a line of argument which leads to a *reductio ad absurdum;* you may stop traffic, goods, and men, and still you may be defeated by anything that moves, even by the very winds. Besides, the length of time during which organic poisons may be preserved is such that it is impossible to say what interval is necessary before communication with an infected district can be safely resumed by those who have not undergone the test of exposure. No valid argument in favour of human quarantines can be drawn from the success of the stamping-out of cattle plague; there the animal is immediately killed, even if the case be doubtful, and the poison-manufacture is stopped; in human quarantines the production of the poison must go on, and yet its diffusion must be prevented—a matter of far greater difficulty. In one branch of physical science after another precise knowledge has been attained only when the influence of contact has been fully acknowledged, and it is necessary that we should study epidemics on the same principles, but I wish carefully to avoid giving any support to quarantines, against which, in ordinary circumstances, the balance of argument is overwhelming.

The medical reader will, I think, agree that investigations after the model of the cattle plague commission into severe epidemics among any class of animals in this country, with numerous trials of the inoculability of other creatures, promise to be of much use, and might perhaps establish the laws on which the efficacy of vaccination depends. When we look back on the changes of type traceable in the history of epidemics, it is not too much to say that we hold this blessing in the present state of our knowledge by an insecure tenure.

Observations, by competent observers, of human zymotic disease in extreme climates—cold, hot, damp, and dry—would also render much service to medical science.

Our subject is important in relation to the sites, construction, and arrangements of hospitals. The site—urban or rural? It is a matter of necessity, not choice, that it be close to the great masses of population for whom it is intended; but for the feeble and pallid convalescents, and for some chronic cases, there should be a breezy upland or seaside establishment. While the statistics of Sir James Simpson and Dr. Barnes clearly show the injurious effect of the hospital germinal poisons, even when a large deduction has been made for the probably happier lot of those treated at home, they also show that mere town air has no very damaging effect. In construction there should be ample space within and around, free and natural ventilation; in scattered cottages there would not be the same danger of creating an hospital air, that is, of the diffusion of dangerous varieties of germinal matter, as in the many-storied block; but in London, at least, there is here again no choice. Every hospital should have detached accommodation both for cases likely to infect and cases likely to suffer. The aggregation of very large numbers of similar cases, as of phthisis, for example, is probably undesirable; of puerperal cases it is most dangerous. As regards surgical cases, the exclusion of germs from wounds and sores has always been partially effected by different dressings; more recently, after amputations, Maisonneuve has secured this, as well as coaptation, by the exhaustion of his pneumatic cap placed on the stumps. The chloride of zinc and many other substances have been used to coat the cut surfaces with a protective film, and now carbolic acid is relied on. The benefit of these contrivances is likely to be greatest in those hospitals which have been most crowded, and it is to be hoped that their use will not be allowed to supersede liberal space and free air.

Lastly, it will be well to consider the bearing of our subject on the disposal of excreta. The object to be kept in view is to destroy all germs or ova which they may contain, and to return the chemical elements to earth and air, or to the form of food by the shortest route. Probably of all plans the best is the Mosaic—immediate burial; in this case the eventual result is nearly the same as if they were burned and the ashes given to the soil; in either case vegetables restore the elements to the form of food. This plan is perfectly safe. So also is the disposal of such matters in the open sea, and their return in the form of fish. In the endeavour to collect the excreta in the most convenient way for the land many plans have been adopted, some of them most dangerous, the worst being the cesspool under the house, the best being the English watercloset, with a plentiful water supply and quick flow of the sewage to a distance, where its disposal is a separate question. The immense advantage to the health of the population gained by this plan was not even counterbalanced by the fouling of our streams.

Sewage marshes on a large scale will not be entirely devoid of danger; it is obvious that germs of disease may thus be thrown into the air much in the same manner, though not to the same extent, as if the filth had been left on the surface without passing through any system of sewers. The passage will not destroy the vitality of all kinds of morbific germinal matter; once thoroughly soaked into the soil, it would probably be harmless, but, failing this, it may rise into the air as the fluids evaporate, or it may reach drinking-waters, and great mischief may result. Much careful investigation of the acreage over which it would be required to distribute it on soils more or less porous is needful, and experiments—for they are such—should be made as far from dwellings as possible. Against slight detriment to health must be set the cheapening of food for animals and men. If the whole sewage of London should ever be thus applied in the manner of irrigation, it will probably require extra care and cleanliness to maintain health in or near the place, just as it does in Holland, a natural northern outfall of Europe, or in any other large tract of estuary or delta land.

Why should such tracts be so unhealthy? It is certainly not owing to the mingling of salt and fresh water; the sulphates of sea water, added to decomposing matters, may occasionally evolve sulphuretted hydrogen, but large tracts of salt marsh, where the waters constantly mingle, are not unhealthy. Neither is it owing to decomposing matters, for if the morbid poisons were decomposing matters they would be constantly disappearing. But, grant for a moment the existence of those small germs to which we ascribe the malarious fevers, and if you will suppose that they are equally distributed throughout the world, rain would at once bring them in largest quantity to the marsh and estuary districts; in the sea they would die or become the food of conchifera; while in the estuary soil they would find their appropriate nidus and home. It has even been proposed by Dr. Angus Smith to apply disinfectants to malarious grounds, "especially in such places as railway cuttings in India;" since the growth of the yeast plant is suddenly stopped by sulphurous acid, it is not improbable that this might be successful, if it were practicable. The most permanently effectual means, and those by which the malarious fevers have been almost extirpated from this country, are cultivation, drainage, and the cutting down of superfluous timber.

But to return to the sewage stream. Most of the germinal matter of human disease will probably be harmless to cattle, but there is yet another risk, and that is the diffusion of entozoa. We need, in fact, some simple and cheap process which would destroy low forms of life, and leave the sewage fit to irrigate pastures. Carbolic acid, or as they call it on the Continent phenic acid, seems at present the best agent. In Mr. Crookes' report on the use of disinfectants in cattle plague there is much interesting matter as to its effect on infusoria and insects, when used in vapour or solution more or less diluted. I quote from his summary the following:—"In tracts of land to which sewage disinfected with carbolic acid has been applied the sheep are free from foot rot, the potatoes from disease. Obnoxious insects, such as the turnip-fly, gnats, and dung-flies, are absent; and grubs, larvæ, and the lower forms of animal life, and infusoria (the invariable accompaniments of putrefying matter), disappear, whilst vegetation becomes remarkably healthy and luxuriant." Really an agreeable picture. The strength in which this acid requires to be used, in order to destroy morbific germinal matter, is as yet quite undetermined. To kill those particles which affect wounds so detrimentally, Professor Lister considers it advisable to use it pure, or nearly so; of course, in sewage it must be very highly diluted, and to what extent dilution can be carried without impairing its efficiency in this respect has yet to be determined.

Heat is a valuable disinfectant. Dr. Henry found vaccine to lose its properties between 120° and 140° Fahrenheit; to the latter or to a still higher temperature clothes, &c., have been often subjected. In the hottest countries, Arabia, and the neighbouring part of Africa, the surface of the soil, where it is not cooled by evaporation, must frequently be heated by the sun so as to destroy either animal or vegetable germs. This is probably one reason of the healthy air of the deserts of Arabia, Upper Egypt, and Nubia. This principle might sometimes find useful application in extremely unhealthy localities, such as the West Coast of Africa, when a site for a house cannot be procured except upon black alluvium. A more healthy dwelling would probably be obtained by burning the surface earth before building, as clay is here burned, by the aid of waste coaldust from the steamers. The poisons of cholera and dysentery, and the ova of entozoa in water, may be destroyed by boiling it.

In conclusion, some knowledge of sanitary laws is at least as useful as knowledge of the laws of our country. Ignorance of the latter is not allowed as an excuse for transgressing them. So also of hygienic laws. The infraction of these, even though unconscious, is followed by terrible penalties, visited, not only on the individual, but on his offspring, on his neighbours, and even on those in distant lands. For the healthy nutrition of our bodies we are dependent on each other, not only in the supply of food, but even as regards minute processes of assimilation, which some wandering but active living particle may at any moment disarrange. Every man is thus interested in the health of every other man,

"Nemo sibi vivat."

To the reader whose courteous attention has brought him to this point by honest perusal I tender my thanks, and wish him a hearty farewell.

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